APPLICATION FOR
UNITED STATES LETTERS PATENT

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

Be it known that I, Steven Durham

a citizen of the United States, residing at Ponte Vedra Beach

in the County of St. Johns and State of Florida

has invented a new and useful ENERGY GENERATING SHELTER SYSTEM AND METHOD

of which the following is a specification.

Attorney Docket
No. 40120-10024

ENERGY GENERATING SHELTER SYSTEM AND METHOD

Cross Reference to Related Application

This is a continuation-in-part of prior application No. 09/902,390 filed July 10, 2001, now U.S. Patent No. _____, issued _____, 2003.

Technical Field

The present invention relates to a carport shelter, and more particularly to a shelter having or composed of a photovoltaic device capable of generating electricity from sunlight or other sources of light.

Background of the Invention

A need exists for a shelter that protects vehicles from natural environmental concerns while still providing an unobstructed view of the vehicles.

A need also exists for a shelter that reduces the amount of sun, UV rays, rain, hail, light snow and other elements that possibly could make contact with vehicles, yet also remains aesthetically pleasing, complements the surroundings, and allows the car to be on display.

In addition, a need exists for a shelter suited for people that do not desire to keep their vehicles in a garage or other enclosed structure, but still want to keep them sheltered, particularly without significantly obstructing the natural view of the surrounding environment. A need further exists for a carport or shelter that is capable of producing electricity when exposed to sunlight or artificially generated light.

Summary of the Invention

In accordance with the present invention, a shelter, which may be a carport, is provided. The shelter can include either a semi-flexible or

tensioned/membrane roof, that can be in the shape of a rigid, concave canopy, or any other desired shape that is composed of a rigid self-supporting material. Consequently, the canopy in one embodiment can be a frame-less structure, that is, a frame to support the canopy is not required. The canopy can be of any desired size or area and typically has a width and length larger than the width and length of a standard size automobile. The shelter typically further includes a suitable supporting structure that rigidly connects to the canopy, so that the canopy is mounted in a fixed position spaced above the ground a desired distance. Preferably, the shelter structure in accordance with the invention includes a longitudinally extending support member rigidly secured to the canopy and to a laterally, generally horizontally extending supporting structure that has an end or a portion that is laterally spaced from the canopy. The end or portion of the laterally extending supporting structure that is laterally spaced from the canopy can be secured to another structure that provides the desired elevation for the rigid canopy. Typically, that structure will be a generally vertically extending post member mounted directly or indirectly to the ground, or to other suitable structure.

In accordance with one aspect of the invention, a rigid, concave canopy is provided that is composed of light transmissive material which may be transparent or translucent. In another embodiment, it is composed of transparent, colored or opaque material, which may include a one-way mirrored material, on either side and typically so that a person below the canopy can see upward through the canopy, but a person above the canopy cannot see downwardly through it. Thus, it is contemplated that in one embodiment the canopy will provide for a substantially unobstructed view of both the vehicle underneath it and the surrounding environment.

In accordance with another aspect of the invention, the rigid canopy, when concave, has a radius of curvature in the range of from about 5 to 30 feet or more. Such a radius of curvature will provide for an adequate shelter for the vehicle, while also providing enough of a curve for debris and rain runoff. Alternatively, the canopy can be of any desired shape or curvature.

In accordance with another aspect of the invention, the rigid canopy is composed of a plurality of rigid, self-supporting concave panels attached or secured together in side-by-side complementary relationship. While the canopy material is rigid, it is to be understood that rigid materials inherently will flex to some degree. In one embodiment, each concave panel is suitably secured to another concave panel with, for example, a correspondingly concave or flexible channel member, or other suitable structure. In another embodiment, the transverse edge of each concave panel is secured within a channel member. In another embodiment, the edge of each concave panel is adhered within a channel member.

In accordance with another aspect of the invention, one or more peripheral edging strips are secured to the peripheral edge of the rigid canopy, which rigid canopy may be composed of a plurality of concave panels. In one embodiment, the edging is composed of rigid acrylic material that can be transparent. In another embodiment, the edging is composed of flexible material. The edging provides additional protection of the panels, especially the panel edge, from environmental hazards and shock.

In accordance with another aspect of the invention, the longitudinally extending support member is constructed in a desired configuration and may include two pairs of I-beams, connected together, on a single I-beam or a square beam or pair of square beams with one pair or one beam rigidly attached to the supporting structure and with one pair located on different longitudinal portions of the canopy, which may be different longitudinal half portions of the canopy.

In accordance with another aspect of the invention, the longitudinally extending support member may further include arcuate members laterally spaced along the canopy length that are formed to allow attachment to the canopy at two transversely spaced areas taking into account the canopy's radius of curvature, and have straight vertically extending ends. It is contemplated that the arcuate members are composed of a rigid structural material. In one embodiment, the arcuate members are composed of stainless steel tubing formed to provide the desired configuration such as in an arch shape. The arcuate members are

composed of any suitable material including aluminum, steel and composite materials.

In accordance with another aspect of the invention, each arcuate member further includes reinforcing arms that are suitably attached, such as by welding, to inside the tubular arch and also have straight ends. It is contemplated that the reinforcing arms are composed of the same material as that of the arcuate member.

Alternatively, in place of the arcuate members may be utilized angular support members.

In accordance with another aspect of the invention, the longitudinally extending support member further includes flanges that attach the ends of the arcuate members to the rigid, concave canopy. The flanges provide for a secure attachment to the rigid canopy and allow a relatively uniform distribution of forces on the canopy. It is contemplated that the flanges attach to the canopy by any suitable structure, such as, for example, with threaded fasteners, which may be by bolts. It is alternatively contemplated that the flanges attach with a suitable adhesive. The surface of the flange that abuts the canopy may have a curvature to match the canopy in the area of abutment.

In another aspect of the invention, curved or angled flanges are located underneath the canopy in a location directly opposite and complementary to the flanges. This embodiment will allow the concave panels to be rigidly secured and held together.

Alternatively, bolts may be embedded in the canopy material, which can eliminate the need for a bottom flange.

Numerous advantages may be realized by the present invention. For example, the unobstructed view of the sheltered vehicle can provide for a display and draw attention to the sheltered vehicle. This factor will appeal to people who wish to draw attention to their vehicles, possibly because of their rarity or prestige. Alternatively, commercial dealers that display many vehicles, for example, car or boat dealers, will be able to fully put on view and display the vehicles, while simultaneously protecting such vehicles from environmental elements.

In addition to providing for a full view of the protected vehicle, the transparent canopy has the advantage of preserving the view of the surrounding environment in which the shelter is placed. This aspect will especially appeal to people that live in aesthetically pleasing locales that include, for example, mountains, water, trees, flowers, or even other buildings. With this shelter, people will be able to protect their vehicles with only a very minimal obstruction on the view of the corresponding surrounding area.

In accordance with another aspect of the invention, a shelter capable of producing electrical energy is provided. The shelter includes a canopy defining a sheltered area. The canopy may be rigid or flexible and can be of any desired shape or material, including cloth or a membrane material. A photovoltaic device capable of producing an electrical current when exposed to a light source is associated with the canopy to collect sunlight to produce electricity. A supporting structure, which can be constructed without walls, is connected to and supports the canopy and permits substantially unobstructed access to the sheltered area. The energy generating shelter may further include an electrical load operatively connected to the photovoltaic device for utilizing the electricity generated by the photovoltaic device when the photovoltaic device is exposed to light. The canopy can be mounted for movement to follow the light source such as the sun to maximize electrical energy production.

The photovoltaic device may be any suitable photovoltaic device or material known in the art for converting light energy into electrical current. For example, such devices are typically rigid crystalline photovoltaic systems or flexible thin film amorphous photovoltaic systems and may be composed of numerous photovoltaic cells or modules. The photovoltaic device is associated with the canopy by any suitable arrangement. The photovoltaic device may be supported by the canopy or the photovoltaic device may be applied directly to the canopy surface. Alternatively, the photovoltaic device may be integral to or dispersed within the canopy. The photovoltaic device may even constitute the canopy itself.

In one aspect of the invention a first photovoltaic device may be associated with the top surface of the canopy and oriented to receive sunlight. A

second photovoltaic device may be associated with the underside of the canopy and directed to the ground. An electric or other type of light may be affixed to the underside of, or located below, the canopy to illuminate the sheltered area during periods of darkness. The first and/or second photovoltaic device may generate electricity while the light is illuminated.

In another aspect of the invention, the photovoltaic device includes a light emitting diode (LED) or other light emitting device, which can be in the form of a layer. The LED is preferably a thin film, flexible organic light emitting diode (OLED) sandwiched or contained between an upper photovoltaic material and a lower photovoltaic material. Transparent photovoltaic material is preferably used allowing the thin film OLED layer to emit light through the lower photovoltaic material to illuminate the sheltered area at night or other periods of low light or darkness. The light emitting layer may also be a phosphor layer or coating, associated with the photovoltaic device so that the photovoltaic device generates electricity from light produced by the LED or light emitting layer, including at night.

The electrical load that may be connected to the photovoltaic device may be any system or device that may utilize the electricity generated by the photovoltaic device as is commonly known in the art. For instance, the electrical load may include all or part of the power demand of a building or structure adjacent the energy-generating shelter. Alternatively, the electrical load may be the power distribution grid of a nearby utility company whereby the electricity produced by the shelter is distributed to other power consumers located throughout the power grid. The electrical load may also be a battery or other electrical energy storage device as desired. The battery or storage device may be used to power any of the previously described light sources for illuminating any outdoor area, preferably the sheltered area.

In accordance with another aspect of the present invention, a method of producing electricity is provided. The method includes providing a canopy defining a sheltered area and having a photovoltaic device associated with the canopy wherein the photovoltaic device is capable of producing an electrical current when exposed to a light source. The canopy can be supported without walls above an outdoor vehicle parking area with a supporting structure but

without walls so that substantially unobstructed access, including ingress and egress of the motor vehicles, to the parking area is permitted. The method further includes exposing the photovoltaic device to light in order to generate electricity and connecting an electrical load to the electricity. The electrical load may include a power meter allowing reverse metering of the power meter with the electricity produced by the shelter.

The energy producing shelter is well-suited for large parking lots and provides the multiple benefits of protecting parked vehicles from sunlight as well as providing an alternate power supply. Thus, a further advantage of the present invention is to reduce the strain on a local power grid by supplying power to adjacent buildings with the electricity generated by the shelter. Alternatively, the shelter-generated power may be sent directly to a utility company or corresponding power grid and distributed to other users within the grid, particularly during peak power demand periods. When used on a large scale, the shelter-generated electricity may assist in preventing rolling brownouts or blackouts in a local power grid.

Brief Description of the Drawings

FIG. 1 illustrates a perspective view of a device in accordance with the present invention;

FIG. 2 illustrates a top plan view of the device of FIG. 1;

FIG. 3 illustrates a front elevation view of the device of FIG. 1 in an upright position;

FIG. 4 illustrates an enlarged perspective front elevation view of a portion of the device of FIG. 1;

FIG. 5 illustrates a sectional front view of a portion of the longitudinally extending support member of the device of FIG. 1;

FIG. 6 illustrates a side elevation view of a portion of the device of FIG. 1;

FIG. 7 illustrates a sectional view along line 7-7 of FIG. 6;

FIG. 8 illustrates a sectional view along line 8-8 of FIG. 6; and

FIG. 9 illustrates a sectional view of an alternate embodiment of attaching structure useful in accordance with the invention;

FIG. 10 illustrates a perspective view of an energy-generating shelter in accordance with an alternate embodiment of the present invention;

FIG. 11 is a side elevation view of an alternate embodiment of the energy-generating shelter view in accordance with an alternate embodiment of the present invention; and

FIG. 12 is a sectional view of an alternate embodiment of the present invention.

Detailed Description of the Invention

Referring to the Figures generally, there is illustrated a carport 10 in accordance with one aspect of the invention. Carport 10 includes a rigid, self-supporting concave canopy 12 that is composed of a rigid self-supporting material, and that typically is of a width and length larger than the width and length of a standard size automobile A. Carport 10 also includes a supporting structure 14 that rigidly connects to and extends vertically from canopy 12. Carport 10 further includes a horizontally extending longitudinally extending support member 16 that rigidly secures to supporting structure 14 and has an end 18 that is laterally spaced from canopy 12. Member 16 may be an I-beam as illustrated or may be any desired structure such as a tubular or box-like structural member, as long as it is capable of providing the desired structural support.

Carport 10 further includes a generally vertical post member 20, which in this case is an I-beam, although any suitable structure can be used, that has an upper portion 22 to which laterally spaced end 18 of support member 16 is connected, as illustrated in FIGS. 1 and 3. I-beam vertical post member 20 extends laterally past the edge of canopy 12, as illustrated in FIGS. 1 and 3. Post member 20 is suitable for mounting to a supporting surface, such as a base plate 24, to which it is mounted with bolts 24', as illustrated in FIGS. 1 and 3. Alternatively, post member 20 can be mounted to a foundation (not shown) or other suitable structure. Alternatively, end 18 could be mounted to a building or other suitable structure to provide the desired elevation for canopy 12.

Rigid, concave canopy 12 can be composed of a desired material and may be either light transmissive material or transparent material and optionally can be

also composed of light emissive material. Thus, if desired, an unobstructed view of both what is sheltered underneath the canopy and of the corresponding, surrounding environment can be provided, as shown in FIGS. 1 and 3, for example, particularly when the canopy is transparent.

Rigid, concave canopy 12 has a radius of curvature R of from about five to thirty feet, as shown in FIG. 3. Such curvature will provide enough of a slope for debris and rain runoff.

Rigid, concave canopy 12 of carport 10 may be composed of a single panel (not shown) or a plurality of rigid, self-supporting concave panels 26 secured in side-by-side relationship, as best shown in FIG. 2. Each concave panel 26 is secured to another concave panel 26 with a concave channel member 28, which is shown in FIGS. 6 and 8. Each concave panel 26 can be bonded into concave channel member 28, which can be accomplished by use of a suitable adhesive, for example, or by a friction fit. Outer concave panels 26 are secured into a concave panel edging strip 30, which is shown in FIGS. 6 and 7. Panel edging 30 protects the edges of panels 26 from the elements and ensures that they remain secured together.

Rigid, concave canopy 12 is suspended from supporting structure 14, as illustrated in FIGS. 1-3. Alternatively, supporting structure 14 could be located below the canopy instead of above (not shown).

In the illustrated embodiment, supporting structure 14 is composed of a plurality of longitudinally spaced arcuate members 32 that conform to the canopy's radius of curvature and have vertically extending straight portions 34, as best shown in FIGS. 4 and 6. Arcuate members 32 are composed of a rigid material, such as tubular steel or aluminum, for example, and may be composed of stainless steel tubing that is bent or otherwise formed to provide the desired configuration. Each arcuate member 32 connects to canopy 12 at two transversely spaced apart locations, as illustrated in FIG. 4.

Arcuate members 32 are mounted to a longitudinally extending support member 33 that forms part of support structure 14 by means of reinforcing arms 36, 36' and 36", which together with arcuate members 32, form a rigid structure, as best illustrated in FIG. 4. Arcuate members 32 in one embodiment have a

central horizontally extending portion 32', as shown in FIGS. 3 and 4, for example. Arcuate members 32 can be of a shape as desired. Reinforcing arms 36, 36' and 36" provide additional support for arcuate members 32 to ensure structural integrity. Reinforcing arms 36, 36' and 36" include ends 38, 38' and 38" and can be composed of the same material as that of arcuate member 32. Arms 36, 36' and 36" each have ends 36a, 36a' and 36a" and are rigidly secured to support member 16, such as by welding or otherwise securing a block 56, 56' and 56" to a respective plate 58 or for blocks 56 and 56" to vertical side 42' and 44' of I-beams 42 and 44, respectively, such as with nuts and bolts 60 and 62. Alternatively, any other suitable structure could be utilized to form the desired rigid connection of arms 36, 36' and 36" to longitudinal support member 33. The two downwardly depending spaced apart ends 34' of each arcuate member 32 are secured to correspondingly transversely spaced apart areas of canopy 12 as hereinafter described in greater detail with particular reference to FIG. 4.

Longitudinally extending support member 33 is preferably located above the longitudinal centerline of canopy 12, as shown in FIGS. 1 and 4, for example, and may be in any suitable configuration. In an alternate embodiment (not shown), member 42 of longitudinally extending support member 33 or similar structure could extend longitudinally past one longitudinal end of canopy 12 (such as end 12' in FIGS. 2 and 6) for mounting to a vertical post or other member (not shown) or to a wall (not shown), for example, or other supporting structure.

In the illustrated embodiment as shown in FIG. 5, longitudinally extending support member 33 is composed of two pairs of I-beams, 42 and 44 respectively, connected together by any suitable structure, such as by welds W, for example, one pair being located on each longitudinal half portion of canopy 12, as shown in FIG. 2. The longitudinally extending support member 33 is securely connected to a transversely extending support member 16, which is illustrated in FIGS. 1 and 2, for example, and as illustrated is an I-beam. End plates 48 are located at the ends of longitudinally extending support member 33 that are secured to the vertical portion 16' of I-beam or member 16 via bolts, as illustrated in FIGS. 4 and 5 or other suitable structure.

Ends 34' of members 32 have flanges 50 that attach ends 34' of arcuate members 32 to rigid, concave canopy 12, as shown in FIGS. 3, 4 and 6. These flanges 50 preferably have a curved contacting surface for contact with the curved surface of panels 26 and thus preferably are curved to the corresponding curvature of the concave panel, as shown in FIG. 3. In addition, each flange 50 has a complementary flange 52 located on the opposite surface of canopy 12 in a location directly corresponding to flange 50 and that is curved to correspond to the curvature of the concave panel, as shown in FIGS. 3 and 4. Each pair of flanges 50 and 52 are secured together with one of panels 26 therebetween by suitable fasteners such as nuts and bolts 62 that extend through the respective panels 26, as shown in FIG. 4. Alternatively, a suitably curved blocking member could be located between the flanges and respective panel 26. To isolate panels 26 from vibration and/or shock from support structure 14, a thin, flexible bushing or pad (not shown) may be interposed between each of flanges 50 and 52 and respective panel 26, which may be constructed of suitable material as desired, such as rubber, vinyl material or polyurethane material, which may be transparent, for example.

An alternate attachment system is illustrated in FIG. 9. A bolt 64 has an end 66 that is embedded in canopy 12a, which is similar to canopy 12. End 66 is preferably of relatively large cross-sectional area to distribute forces over a relatively large area of canopy 12a.

Flange 50', similar to previously described flange 50 is shown in a fragmentary sectional elevation view. Interposed between flange 50' is a bushing 68 which may be constructed of relatively flexible material such as rubber, vinyl material or polyurethane material, which may be transparent. A nut 70 is threadably fastened onto threaded portion 72 of bolt 64 to secure flange 50' to canopy 12a. Any other suitable structure to fasten the supporting structure to the rigid canopy may be used in accordance with the invention.

FIGS. 10-12 depict alternate embodiments of the present invention. A shelter 100 in accordance with the invention is capable of producing electrical energy. Shelter 100 is wall-less and includes one or more canopies 102a and 102b, supporting structure 104a and 104b. One of ordinary skill in the art will

realize that shelter 100 may include a plurality of canopies and supporting structures (as shown in Fig. 10) or a single canopy and supporting structure without detracting from the present invention. Canopies 102a and 102b each have a width and a length defining a respective sheltered area 108a and 108b thereunder. Preferably, the dimensions of canopies 102a and 102b are such that each sheltered area 108a and 108b provides sufficient cover for at least one car, a sport utility vehicle, a small truck, or similar vehicle. Canopies 102a and 102b may be composed of a light transmissive or transparent material as previously described with tinted or untinted glass, plexiglass or similar methacrylate derivatives being preferred and can optionally incorporate or be composed of light emissive material. Canopies 102a and 102b each may be rigid or flexible, curved, substantially flat, composed of a single panel or composed of a plurality of panels secured in a side-by-side relationship as previously described.

Each supporting structure 104a and 104b can be of any desired or suitable construction or design and as illustrated includes a respective vertical support member 110a and 110b, a longitudinal support structure member 112a and 112b and arch supports 114a and 114b to support each respective canopy 102a and 102b above the ground as shown in FIG. 10. Supporting structures 104a and 104b support respective canopies 102a and 102b without walls permitting substantially unobstructed access to sheltered areas 108a and 108b. Consequently, vehicles 116a and 116b may readily enter and exit respective sheltered areas 108a and 108b and be substantially sheltered or covered by respective canopies 102a and 102b while parked in each sheltered area. One skilled in the art will appreciate that shelter 100 may be dimensioned to adequately shelter a plurality of vehicles parked in parking spots 118a, 118b and 118c in a similar manner.

Associated with each canopy 102a and 102b is a photovoltaic device 120 capable of producing an electrical current when exposed to a light source. Typically, device 120 is a photovoltaic device and any suitable photovoltaic device may be used in the present invention. Photovoltaic devices which generate an electrical current when exposed to a light source are well known in the art. Typically, such devices include a semiconducting component, collectors,

grid wires, a contact layer, an encapsulant and optionally a mechanical (*i.e.*, lenses or reflectors) or chemical (*i.e.*, gallium arsenide) concentrator used to increase electrical output and/or an up/down converter (*i.e.*, aluminum arsenide, gallium phosphide, or boron in cubic silicon). Nonlimiting examples of materials known to be photovoltaic are organic or inorganic semiconductors composed of silicon with or without germanium and compound semiconductors such as cadmium sulfide-copper sulfide, gallium arsenide, cuprous oxide, cadmium telluride, cadmium selenide, copper indium diselenide, copper indium gallium diselenide, indium gallium arsenide nitride, lead dioxide, titanium dioxide, dye sensitized solar cells (organic), hybrid solar cells and combinations thereof. The skilled artisan will recognize that photovoltaic device 120 may be configured as a rigid crystalline photovoltaic system or as a thin film flexible amorphous photovoltaic system as is commonly known in the art.

Photovoltaic device 120 may be associated with canopies 102a and 102b in any suitable manner as is commonly known in the art. For example, the skilled artisan will appreciate that photovoltaic device 120 may be an array of self-contained solar panels affixed to or otherwise supported by either canopy 102a or 102b. Alternatively, each canopy 102a and/or 102b may serve as a substrate upon which photovoltaic device 120 may be applied as a flexible thin film photovoltaic system. Photovoltaic device 120 may also be integral to or dispersed within canopy 102a and/or 102b and can be of any suitable type, for example, either a crystalline structure or an amorphous thin film system. When adequately encapsulated, photovoltaic device 120 may even be utilized to form the canopy itself. It is understood that canopy 102a and/or 102b as well as photovoltaic device 120 may be continuous or non-continuous as it may be necessary to intersperse supporting devices between adjacent canopy panels and/or photovoltaic device panels. Regardless of the association between photovoltaic device 120 and canopies 102a and 102b, it is preferred that photovoltaic device 120 is suitably oriented to receive sunlight.

It is apparent that the most effective photovoltaic energy generation will occur when shelter 100 is situated in high and direct sunlight exposure areas, direct sunlight being most preferred. To maximize sunlight exposure, longitudinal

support members 112a and 112b and arch support members 114a and 114b are preferably disposed on the underside of each respective canopy 102a and 102b. It is contemplated that application of shelter 100 to the open sun-exposed areas of large parking lots presents particular synergistic benefits of the present invention as will be described hereafter. Shelter 100 may be used at individual residential or commercial parking areas as well. Photovoltaic device 120 could be mounted to any suitable structure or mechanism for movement in order to follow and be oriented towards the sun for maximum efficiency.

Wiring (not shown) extends from photovoltaic device 120 through supporting structures 104a and 104b to deliver the electricity generated by photovoltaic device 120 to electrical load 106. Electrical load 106 may be any device or system that transports, uses, or stores electricity as is commonly known in the art. In one embodiment of the invention, electrical load 106 may be the electrical power demand of a building or dwelling adjacent shelter 100. In this embodiment, the electricity generated by shelter 100 is sent to a power converter or inverter 124 to convert the DC electricity generated by photovoltaic device 120 into AC electricity. The AC electricity is then sent to the building to supplement, reduce or substitute altogether the power supplied by a conventional utility company.

Alternatively, electrical load 106 may be a local power company which utilizes the electricity generated by shelter 100. The AC electricity of power converter 124 may be sent directly to a local utility company to be distributed to other power consumers serviced by the utility company. The shelter-generated power may also be divided among multiple loads. For example, the AC converted electricity generated by shelter 100 may be used to supply power to an adjacent building with any excess electricity delivered to the nearby utility company.

In the event it is not possible to send electricity to the utility company, provision of a power meter 126 operatively connected to either shelter 100 or an adjacent building powered by shelter 100 enables the electricity generated by shelter 100 to reverse meter the power meter 126. Reverse metering occurs when excess electricity produced by shelter 100 spins power meter 126

backwards effectively banking the electricity until it is needed. This enables the operator of shelter 100 to obtain full retail value of any shelter-generated electricity.

In an alternate embodiment of the invention, electrical load 106 may be a battery 122 to store the shelter-generated electricity for later use. Battery 122 may be electrically connected to a light 128 as shown in FIG. 10. Light 128 may be used to illuminate sheltered area 108a and/or 108b or any outdoor area such as a parking lot, for example, during nightfall or other periods of little or no sunlight. It will be appreciated that photovoltaic device 120 may generate electricity when exposed to light emitted from light 128 or other artificial light.

FIG. 11 shows another embodiment of the present invention wherein a photovoltaic device 130a is associated with the upper surface of a canopy 132 and a photovoltaic device 130b is associated with the underside surface of canopy 132 in any suitable manner as previously described. Photovoltaic device 130a is oriented toward the sun while photovoltaic device 130b is directed toward the ground. Photovoltaic devices 130a and 130b may be composed of transparent flexible film photovoltaic material as is commonly known in the art enabling photovoltaic devices 130a and 130b to be composed of multiple layers of photovoltaic material.

An electric light 134 of any desired type is attached to the underside of, in between the layers or located below, canopy 132 and may be operatively connected to battery 122. Light 134 may be any suitable light emitting device including, but not limited to incandescent, fluorescent, metal ion, or halogen based light sources as well as an organic or inorganic light emitting diode. Light 134 may be a conventional bulb configuration or a thin film system as is commonly known in the art. Shelter-generated electricity stored in battery 122 may then be used to power light 134 and illuminate sheltered area 135 and vehicle 137 during periods of darkness. The presence of photovoltaic device 130b on the underside as well as on the top side of canopy 132 allows for the generation of electricity when light 134 is illuminated. It is understood that light 134 may include a switch enabling an operator to select either battery 122 or conventional power as the light power source.

FIG. 12 depicts a further embodiment of the present invention wherein a photovoltaic device 138 is composed of a layer of photovoltaic material 140a oriented to receive sunlight, a thin layer light emitting material, which can be light emitting diode (LED) 142 or other light emitting or emissive material, including a phosphor layer or coating, for example. Light generated by the LED or light emissive material can be used to generate electricity by photovoltaic device 138. Stacked layers of photovoltaic devices and light emissive materials can also be used, if desired, and a photovoltaic material 140b oriented toward the ground. Photovoltaic material 140a and 140b may be the same or different. Preferably, both photovoltaic material 140a and 140b are composed of a single layer or multiple layers of flexible thin film transparent photovoltaic material as is commonly known in the art. Photovoltaic device 138 may be associated with canopy 102a and/or 102b in any suitable manner as previously described. Preferably, photovoltaic device 138 is dispersed within or encapsulated by either canopy 102a or 102b.

LED 142 is preferably an organic light-emitting device (OLED). OLEDs are thin, film-based organic substrate layers sandwiched between a transparent anode and a metal cathode to produce surface emitting light. OLEDs are readily deposited on flexible plastic films or foils making them well-suited for use with flexible thin film photovoltaic systems. OLEDs are typically deposited or fabricated on a glass or plastic substrate to form a multi-layer structure having a thickness typically in the range of about one hundred to about several hundred nanometers. The photovoltaic material and OLED can be located on the same substrate and can be vapor deposited or formed in a roll-to-roll system by any suitable method known in the art.

Preferably, photovoltaic device 140b is transparent, enabling LED 142 to illuminate the sheltered area when operatively connected and powered by battery 122 during periods of darkness. A layer of reflective material co-extensive with LED 142 may be placed on the upper side of LED 142 to direct the light emitted from LED 142 substantially downward. One of ordinary skill in the art will recognize that photovoltaic device 140b may generate electricity when LED 142 is illuminated. LED 142 may be operatively connected to a switch allowing an

operator to select whether LED 142 is powered by battery 122 or conventional electrical power. LED 142, dispersed or placed in the roof's vicinity, can be used to display human readable indicia, and thus can be used as an information display while generating electricity simultaneously. Such LED displays and associated equipment to display indicia are well known in the art and are not described in detail herein.

One skilled in the art will readily understand the numerous advantages and benefits of the present invention. The present invention provides the synergistic effect of providing cover from the sun and other natural elements while simultaneously generating electrical power. This makes the energy generating shelter of the present invention well-suited for use in large parking lots at shopping malls, retail outlets, commuter sites and commercial facilities, for example. Parking areas at these locations are typically outdoors and experience high sun exposure. Thus, erecting the inventive electricity generating shelter at such sites would not only provide an alternate energy source but would yield the added benefit of protecting parked vehicles from the elements, i.e., sun, hail and rain, for example, while maintaining the vehicles' interior at a cooler temperature to the favor of vehicle operators departing these sites, as well as illuminate dark areas for safety reasons.

The present era of energy deregulation, rising utility costs and an increased frequency of power outages has increased public awareness of these problems and underscores the need for effective alternate forms of energy generation. Utilized on a large scale, the energy generating shelter of the present invention may significantly reduce the strain on overburdened and aging power grids by supplying power directly to energy consumers adjacent the shelters. Power grid strain may be further reduced by supplying the shelter-generated energy to a nearby utility company for further distribution to other energy consumers. Wide-scale application of the present energy generating shelter may considerably reduce the occurrence of rolling brownouts, blackouts or other problems associated with power grid strain, particularly during peak energy demand periods resulting from, for example, hot sunny days, which are

also the types of days when maximum electricity can be produced by photovoltaic devices.

While the invention has been described with respect to certain preferred embodiments, as will be appreciated by those skilled in the art, it is to be understood that the invention is capable of numerous changes, modifications and rearrangements and such changes, modifications and rearrangements are intended to be covered by the following claims.